TITLE OF THE INVENTION:

Method for Nitrogen Trifluoride Production

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation-in-part of U.S. Patent Application No. 10/299,482, filed 19 November 2002, (abandoned) the disclosure of which is incorporated herein by reference in its entirety.

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BACKGROUND OF THE INVENTION

[0002] There is currently a large and growing requirement of nitrogen trifluoride (NF_3) for use in semiconductor manufacturing. Nitrogen trifluoride may be used, for example, as an etchant or chamber cleaning gas. On an industrial scale, NF_3 is typically manufactured by the fluorination of an ammonium bifluoride/HF complex. There are two principle methods for fluorination of this complex: direct fluorination (DF) and electrochemical fluorination (ECF).

[0003] In the direct fluorination of NH_3 or NH_4^+ salts to produce NF_3, there are competing reactions such as the following:

$$3\,F_2 + NH_3 \longrightarrow NF_3 + 3\,HF \qquad (1)$$

$$3\,F_2 + 2\,NH_3 \longrightarrow N_2 + 6\,HF \qquad (2)$$

$$4\,F_2 + 2\,NH_3 \longrightarrow N_2F_2 + 6\,HF \qquad (3)$$

The most favored reaction according to thermodynamic calculations is (2), which produces only undesirable N_2 and HF. The prior art has attempted to enhance reaction (1) to produce NF_3 and minimize the extent of reactions (2) and (3).

[0004] The prior art provides a variety of direct fluorination methods for the synthesis of nitrogen trifluoride. For example, U.S. Patent No. 4,091,081 describes a direct fluorination method for manufacturing nitrogen trifluoride whereby gaseous F_2 is contacted with liquid (molten) ammonium acid fluoride (AAF) while gaseous NH_3 is separately contacted with the liquid AAF to generate ammonium ions. The '081 process typically provides NF_3 yields of 40-50%. It is operated to maintain a molar ratio of by-product HF to ammonia, referred to as the melt ratio, of 2.0 to 2.5 in the reaction liquid